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Tjader

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(54) **WINCH BOOM AND METHOD FOR TRENCH LESS REPLACEMENT**

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(22) Filed: **Aug. 2, 2013**

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Related U.S. Application Data

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(51) **Int. Cl.**

F16L 1/028	(2006.01)
F16L 1/032	(2006.01)
F16L 55/165	(2006.01)

(52) **U.S. Cl.**

CPC ***F16L 55/1658*** (2013.01); ***F16L 1/028*** (2013.01); ***F16L 1/032*** (2013.01)

(58) **Field of Classification Search**

CPC F16L 1/028; F16L 1/032; F16L 1/036
USPC 405/184.1, 184.2, 184.3, 184.4
See application file for complete search history.

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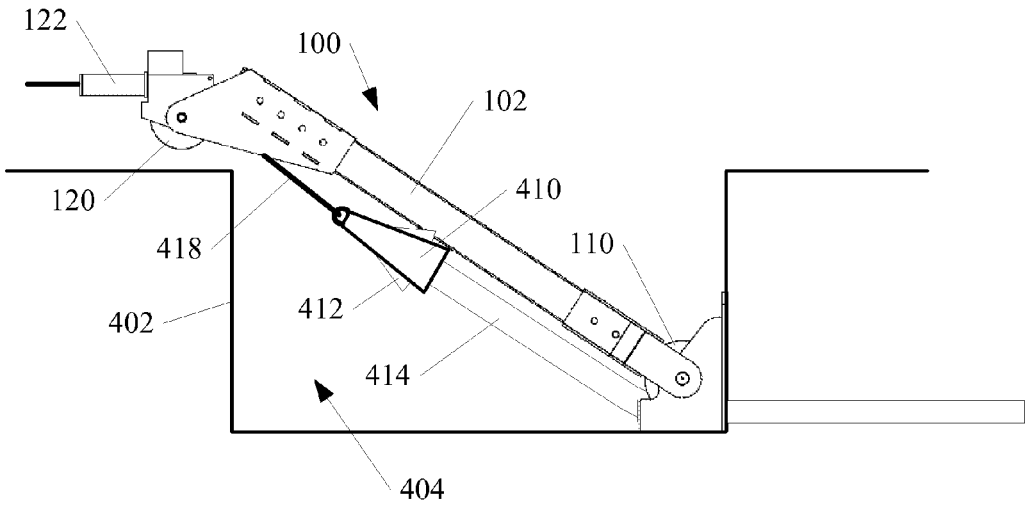
(57) **ABSTRACT**

A pipe replacement system and method are shown. Configurations are shown that include a pulley that does not damage a bursting tool, as the bursting tool is pulled into a pit. Configurations are also shown that include a boom that does not need an extraction cage for the bursting tool.

9 Claims, 5 Drawing Sheets



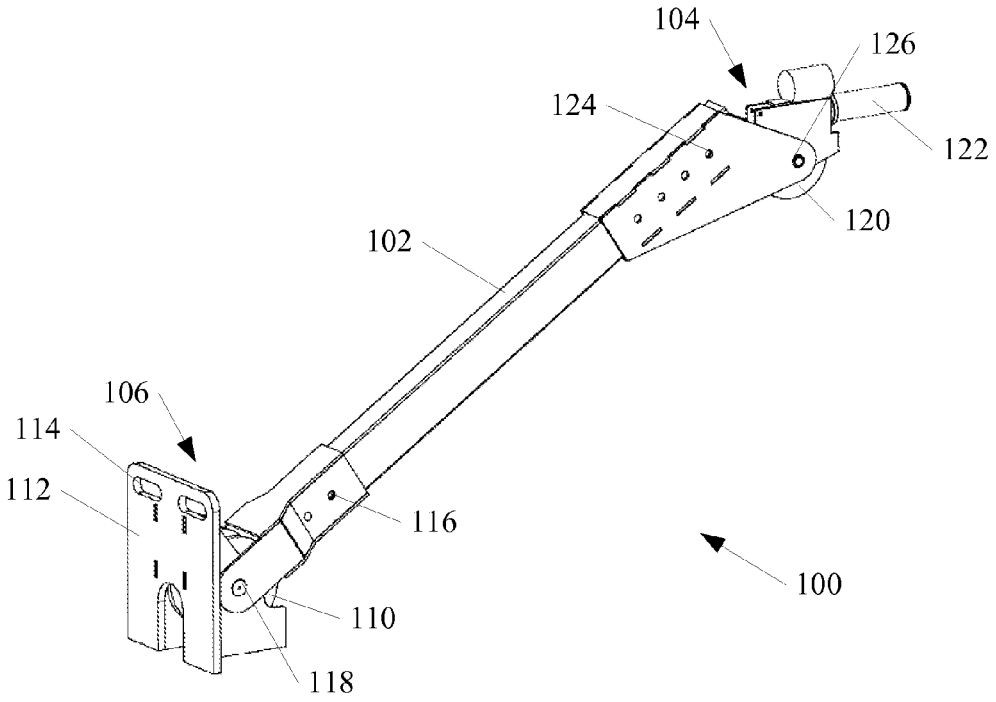


FIG. 1

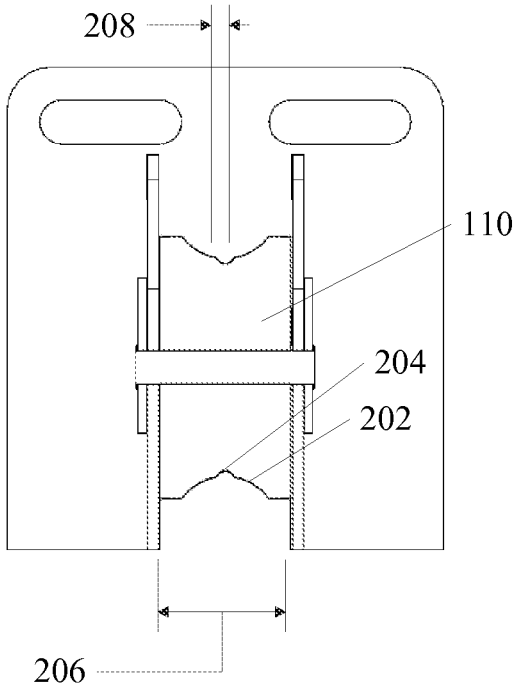


FIG. 2

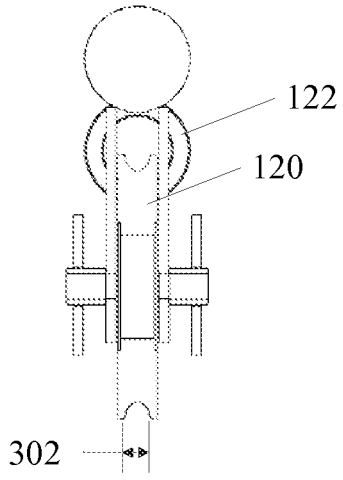


FIG. 3

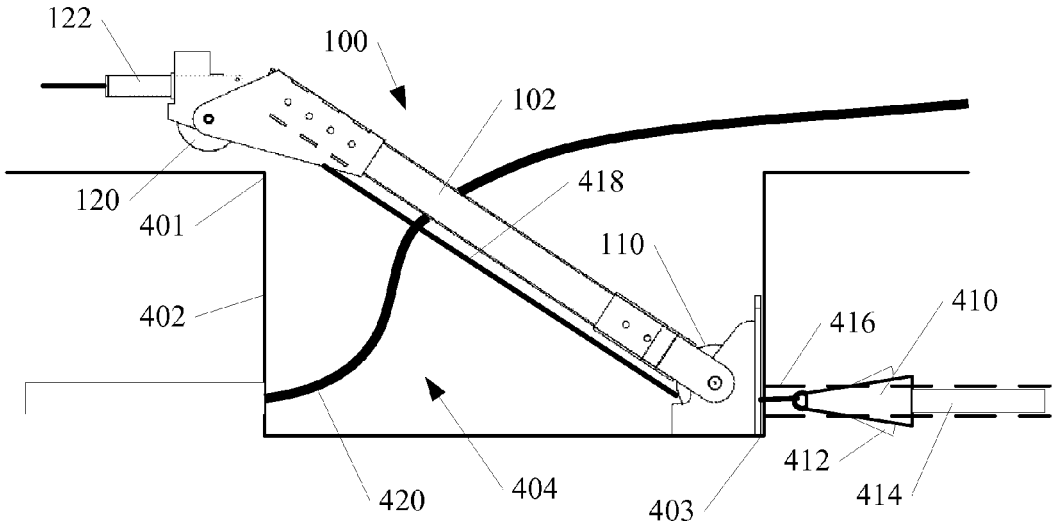

122
100
102
120
401
418
110
402
416
410
412
414
420
404
403

FIG. 4

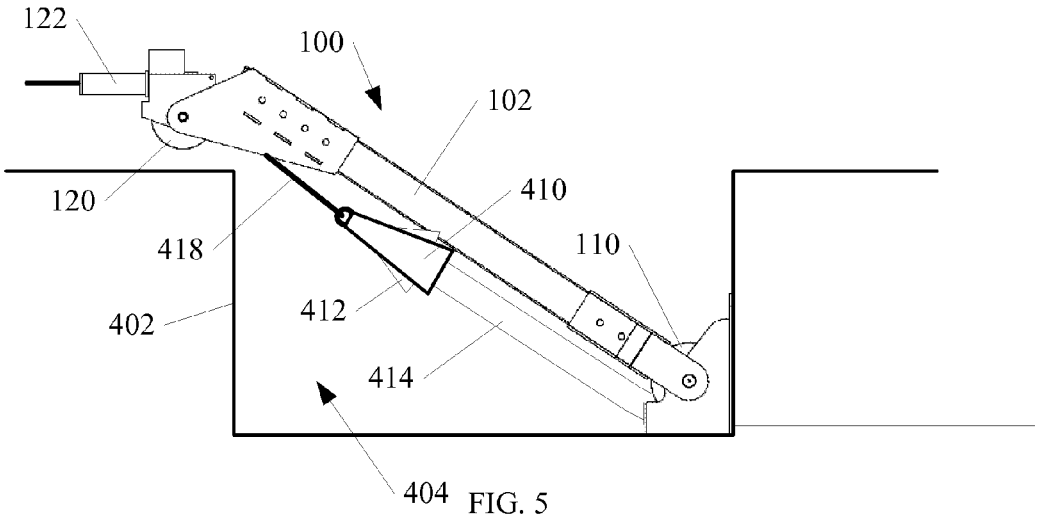

122
100
102
120
410
418
110
412
402
414
404

FIG. 5

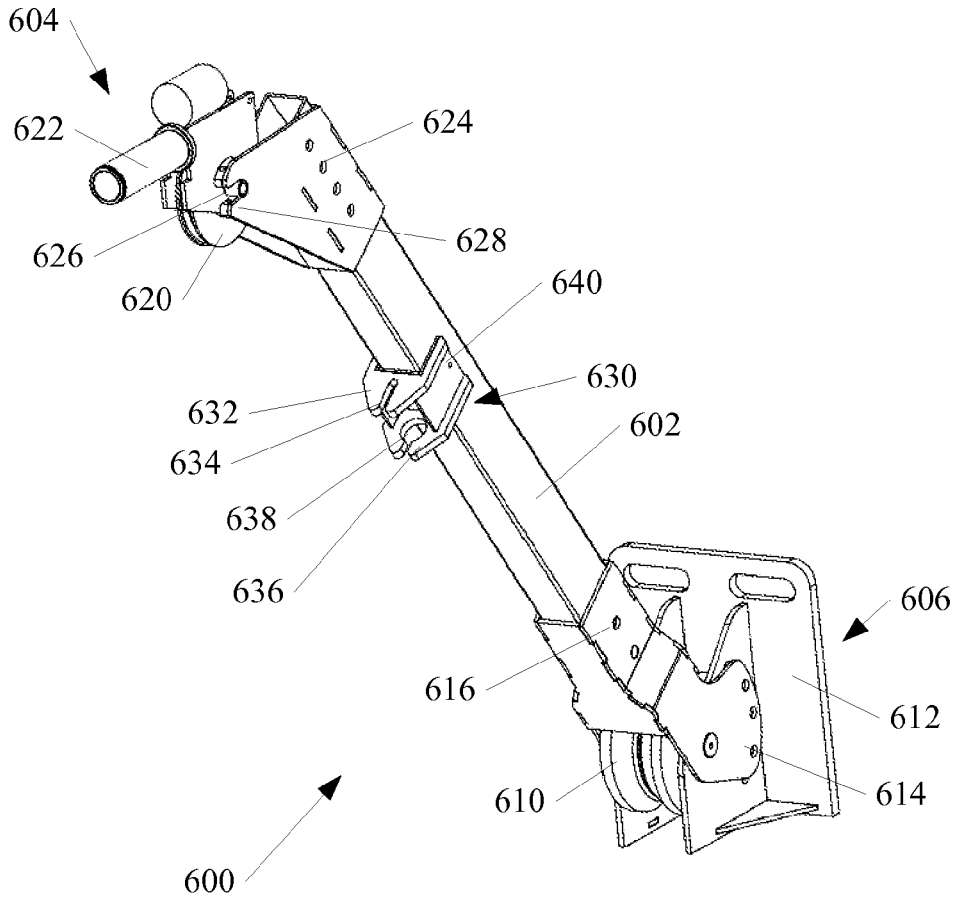

604
622
624
626
628
620
640
630
632
602
634
638
636
606
616
612
610
614
600

FIG. 6

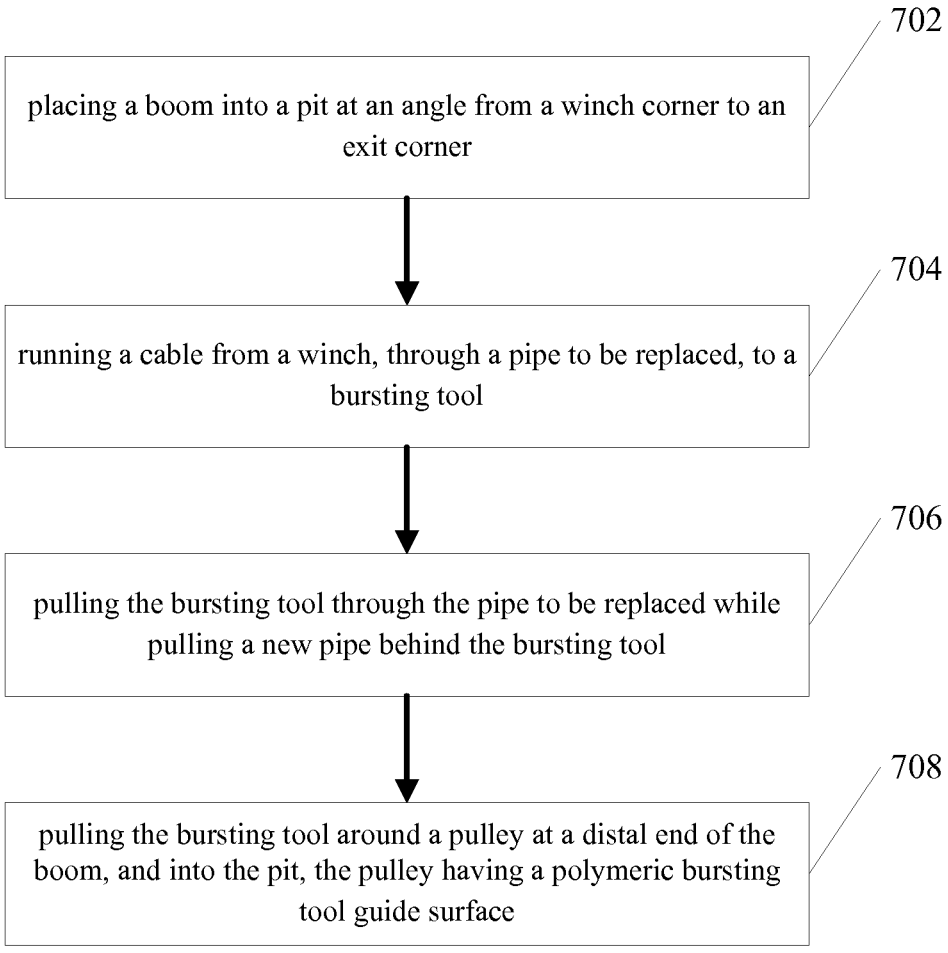

702
placing a boom into a pit at an angle from a winch corner to an exit corner
704
running a cable from a winch, through a pipe to be replaced, to a bursting tool
706
pulling the bursting tool through the pipe to be replaced while pulling a new pipe behind the bursting tool
708
pulling the bursting tool around a pulley at a distal end of the boom, and into the pit, the pulley having a polymeric bursting tool guide surface

FIG. 7

WINCH BOOM AND METHOD FOR TRENCH LESS REPLACEMENT

CLAIM OF PRIORITY

This application is a Non-Provisional of and claims the benefit of priority under 35 U.S.C. §119(e) from U.S. Provisional Application Ser. No. 61/678,909, filed on Aug. 2, 2012 which is hereby incorporated by reference herein in its entirety.

BACKGROUND

Trenchless pipe replacement is useful for replacement of pipes or other buried conduits without the need to excavate the length of pipe to be replaced. An example of trenchless pipe replacement includes pulling a cutting blade with an expander through the pipe to be replaced, and attaching a new pipe behind the cutting blade. The pipe to be replaced is split, and pushed into the surrounding soil, and the new pipe, of equal or larger diameter, is pulled into the new space within the split pipe. Splitters are commonly used for small diameter pipes, and for pipes of a material that lends itself to splitting. Another example of trenchless pipe replacement includes pipe bursting.

Gas lines are one example of pipes where splitting is useful in pipe replacement. An example includes high density polyethylene (HDPE) gas pipe. For example, large quantities of 2 inch diameter HDPE gas pipes are currently in need of replacement. 300 miles of gas pipe in a single city in need of replacement is not uncommon. Given the desirability of minimizing trenches, it is also desirable to minimize the size of entry and exit pits for operating trenchless equipment. Cutting pipes in small entry and exit pits can be a challenge due to the small amount of available space to operate cutting tooling.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows an isometric view of a pipe replacement system according to an embodiment of the invention.

FIG. **2** shows a cross section of a portion of the pipe replacement system from FIG. **1**, according to an embodiment of the invention.

FIG. **3** shows another cross section of a portion of the pipe replacement system from FIG. **1**, according to an embodiment of the invention.

FIG. **4** shows a side view of a pipe replacement operation according to an embodiment of the invention.

FIG. **5** shows another side view of a pipe replacement operation according to an embodiment of the invention.

FIG. **6** shows an isometric view of a pipe replacement system according to an embodiment of the invention.

FIG. **7** shows a flow diagram of a method of pipe replacement according to an embodiment of the invention.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which is shown, by way of illustration, specific embodiments in which the invention may be practiced. In the drawings, like numerals describe substantially similar components throughout the several views. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention. Other embodiments may be utilized and mechanical, structural, or logical changes, etc. may be made without

departing from the scope of the present invention. The term "cable" in the following detailed description is used in a broad sense, and is intended to include any number of flexible lines such as wire rope, and other flexible materials that are sufficiently strong for pipe bursting operations.

FIG. **1** shows an example of a pipe replacement system **100**. A boom **102** is shown, having a first end **104** to couple to a winch (not shown) and a second end **106** to deploy in a pit. A fitting **122** is shown coupled to the first end **104** for attachment to the winch. A reaction plate **112** is shown at the second end. In one example, the reaction plate **112** includes one or more handles **114**. In one example, the pipe replacement system **100** is intended to be assembled by hand at a job site, and it is advantageous to include features such as handles **114** to facilitate assembly of components of the pipe replacement system **100** on site.

In one example, the boom **102** includes a first fastener **116** and a second fastener **124** to further facilitate assembly and disassembly of the pipe replacement system **100**. In the example shown in FIG. **1**, the first fastener **116** and second fastener **124** include pins that may be inserted in one of a plurality of holes to adjust a length of the boom **102**.

A first pulley **120** is shown at the first end **104** of the boom **102**. A second pulley **110** is shown at the second end **106** of the boom **102**. In the example shown, the first pulley **120** rotates about a first pivot **126**. In the example shown, in addition to providing a pivot axis for the first pulley **120**, the boom **102** is allowed to rotate about the first pivot **126**. Similarly, the second pulley **110** rotates about a second pivot **118**. In the example shown, in addition to providing a pivot axis for the second pulley **110**, the boom **102** and/or the reaction plate **112** is allowed to rotate about the second pivot **118**. The ability for the boom **102** to pivot (for example to the approximately 45 degree angle shown in FIG. **1**) provides advantages such as more available space for operations in the pit.

FIG. **2** shows the second pulley **110** from FIG. **1**. The second pulley **110** includes a bursting tool guide surface **202**. In one example, the second pulley **110** further includes a cable groove **204** in a center of the pulley **110**, and within the bursting tool guide surface **202**. The bursting tool guide surface **202** is shown having a width **206** that is greater than a cable diameter. In one example the width **206** indicates a diameter that is sized to substantially match a bursting tool diameter as will be discussed in more detail below. FIG. **2** also illustrates a dimension **208** to indicate a width of the cable groove **204**. In one example the dimension **208** is sized to substantially match a cable diameter.

In one example, the bursting tool guide surface **202** of the second pulley **110** includes a polymeric surface. In one example, the body of the second pulley **110** is substantially formed from a single polymeric casting, such as high density polyurethane. The polymeric surface may function to protect a bursting tool from damage during operation, as discussed in more detail below. In one example, the second pulley **110** may include a metallic body, with a polymeric coating. While polyurethane is used as an example polymeric surface, other polymeric materials are also within the scope of the invention. In one example, any material that reduces damage to a bursting tool over a metallic pulley may be used for the bursting tool guide surface **202**.

FIG. **3** shows the first pulley **120** from FIG. **1**. In the example shown, the first pulley **120** is only sized with a dimension **302** to substantially match the cable diameter.

FIG. **4** shows an example trenchless pipe replacement operation using the pipe replacement system **100** shown in FIGS. **1-3**. The boom **102** is placed into a pit **402** at an angle from a winch corner **401** to an exit corner **403**. By placing the

boom **102** at an angle in the pit **402**, additional space **404** behind the boom is not encumbered, and the space **404** may be more easily accessed and utilized for fittings such as connecting a bypass line **420**. Such a configuration may be particularly useful in a natural gas line replacement operation. When using configurations of pipe replacement systems as shown in the present disclosure, an extraction cage or other extraction structures for removal of the bursting tool may also be eliminated as discussed below. By eliminating the need for an extraction cage, the space **404** behind the boom **102** may further be increased and/or a size of the pit **402** may be reduced. Reducing a size of the pit **402** is desirable to minimize necessary road repair on the surface after the pit **402** is filled in.

FIG. **4** shows a bursting tool **410** pulling in a new pipe **414** while bursting a pipe to be replaced **416**. In the example shown, the bursting tool **410** includes a one or more splitting blades **412**, although the invention is not so limited. In one example, the bursting tool **410** includes a simple conical expander. In one example the bursting tool includes a reciprocating hammer. The bursting tool **410** is being pulled in by a cable **418** connected to a winch (not shown) that would be located at fitting **122**. In one example, the cable passes over the second pulley **110**, along the boom **102**, and over the first pulley **120**. In one example the cable **418** runs within cable groove **204** of the second pulley.

FIG. **5** shows the example trenchless pipe replacement operation from FIG. **4** as the operation progresses. The bursting tool **410** has been pulled into the pit **402**, and is travelling along a length of the boom **102**. In one example, the bursting tool **410** travels over the second pulley **410** in contact with the bursting tool guide surface **202** shown in FIG. **2**. The polymeric surface of the bursting tool guide surface **202** reduces or eliminates any damage to the bursting tool **410**. In particular, in examples where the bursting tool **410** includes splitting blades **412**, the polymeric surface of the second pulley **110** reduces or eliminates any damage to the splitting blades **412**.

Because the bursting tool **410** has now been pulled into the space **404** behind the boom **102**, the bursting tool **410** may now be easily removed from an extending portion of the new pipe **414**. In addition, the extending portion of the new pipe **414** may now be more easily attached to a next section of new pipe in a subsequent replacement operation when continuing pipe replacement from the pit **402**. As noted above, using example pipe replacement systems shown, no extraction cage is needed. The bursting tool **410** is pulled upwards at an angle along the boom **102**, instead of straight into the pit into an extraction cage, as in existing technology. Because of the angle along the boom **102**, the additional space **404** is untouched, and available for work on other fittings, or to reduce a size of the pit **402** needed.

In one example the space **404** is sufficient to allow a reciprocating hammer bursting tool to enter the pit **402**. Reciprocating hammers tend to be long, relative to dimensions of a pit. In one example a winch pulling force may be reduced at an end of a pull, and the long reciprocating hammer may be pulled into the pit without damage to the reciprocating hammer. After the reciprocating hammer is within the pit, the reciprocating hammer is allowed to pivot upwards in line with the boom **102**. Without the available space **404**, this operation would not be possible. An extraction cage would get in the way of removal of any bursting tool as long as a reciprocating hammer.

FIG. **6** shows another example of a pipe replacement system **600**. A boom **602** is shown, having a first end **604** to couple to a winch (not shown) and a second end **206** to deploy in a pit. A fitting **622** is shown coupled to the first end **604** for attachment to the winch. A reaction plate **612** is shown at the second end. In one example, the boom **602** includes a first fastener **616** and a second fastener **624** to facilitate assembly and disassembly of the pipe replacement system **600**. In the example shown in FIG. **6**, the first fastener **616** and second fastener **624** include pins that may be inserted in one of a plurality of holes to adjust a length of the boom **602**.

In the example system **600** of FIG. **6**, a mechanism **614** is included to select and fix an angle between the reaction plate **612** and the boom **602**. In the example shown, the mechanism **614** includes a pin and an array of holes. Other mechanisms for selecting and fixing an angle between the reaction plate **612** and the boom **602**, such as slots and bolts, etc. are also within the scope of the invention.

A first pulley **620** is shown at the first end **604** of the boom **602**. A second pulley **610** is shown at the second end **606** of the boom **602**. In the example shown, the first pulley **620** rotates about a first pivot **626**. In the example shown, in addition to providing a pivot axis for the first pulley **620**, the boom **602** is allowed to rotate about the first pivot **626**. In the example shown, the boom **602** is capable of disassembly from the system **600** using a fork **628** that engages and disengages from the first pivot **626**. This configuration further allows for ease of assembly and disassembly of the system **600** on site.

In one example the second pulley **610** is similar to the second pulley **110** from previous examples. In one example, the second pulley **610** includes a bursting tool guide surface, and a cable groove in a center of the pulley **610**. In one example, the second pulley **610** includes a width that is sized to substantially match a bursting tool diameter. In one example, the bursting tool guide surface of the second pulley **610** includes a polymeric surface. In one example, any material that reduces damage to a bursting tool over a metallic pulley may be used for the bursting tool guide surface.

The system **600** of FIG. **6** also includes a limiter **630**. During some pipe replacement operations, as a bursting tool nears an end of a pull, and is about to exit into the pit, some amount of the pipe to be replaced may be pulled from the ground, and be held captive around the cable. This may be undesirable, as the pipe to be replaced may jam the system at or near the winch.

In the example shown in FIG. **6**, the limiter **630** includes a passage **634** that allows a cable (not shown) to pass through, but the passage **634** is configured to be too narrow to allow an end of pipe to be replaced from passing through. If an end of the pipe to be replaced begins to pull out of the ground, it is stopped by the limiter **634** and is prevented from jamming the winch or the first pulley **620**, etc.

In one example the passage **634** includes a forked slot to allow the cable to be inserted from a side. In one example the limiter **630** further includes a second passage **638** that will hold an end of the pipe to be replaced against the boom **602**. In the event of a pipe to be replaced pulling out of the ground as described above, the second passage **638** will hold the end of the pipe to be replaced against the boom **602**, and in contact with the first passage **634**, thus ensuring that the pipe to be replaced does not pull over the passage **634** and continue up the boom **602** and cause a jam.

In one example the limiter **630** is selectably removable from the system **600**. In one example operation, after a bursting tool enters the pit, the limiter **630** may be removed from the boom **602**, allowing the bursting tool to enter the pit along the boom **602** as far as possible. This allows more room to cut the new pipe and to more easily remove the bursting tool for use in the next bursting operation.

FIG. **7** shows a flow diagram of an example method of pipe replacement according to an embodiment of the invention. In

operation **702**, a boom is placed into a pit at an angle from a winch corner to an exit corner. In operation **704**, a cable is run from a winch, through a pipe to be replaced, to a bursting tool. In operating **706**, the bursting tool is pulled through the pipe to be replaced while pulling a new pipe behind the bursting tool, and in operation **708**, the bursting tool is pulled around a pulley at a distal end of the boom, and into the pit, the pulley having a polymeric bursting tool guide surface.

While a number of advantages of embodiments of the invention are described, any lists of above mentioned advantages are not intended to be exhaustive. Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement which is calculated to achieve the same purpose may be substituted for the specific embodiment shown. This application is intended to cover any adaptations or variations of the present invention. It is to be understood that the above description is intended to be illustrative, and not restrictive. Combinations of the above embodiments, and other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention includes any other applications in which the above structures and methods are used. The scope of the invention should be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.

I claim:

1. A pipe replacement system, comprising:

a boom, having a first end to couple to a winch, and a second end to deploy in a pit;

at least one reaction plate coupled to the second end of the boom;

a pulley coupled to the second end of the boom, wherein the pulley includes a bursting tool guide surface having a diameter greater than a cable diameter, the diameter being sized to substantially match a bursting tool diameter; and

wherein the bursting tool guide surface includes a polymeric surface; and

wherein the pulley includes a cable groove in a center of the pulley, within the bursting tool guide surface.

2. The pipe replacement system of claim **1**, wherein the pulley is a single polymer casting.

3. The pipe replacement system of claim **1**, wherein the pulley includes a metallic pulley with a polymer coating.

4. The pipe replacement system of claim **1**, wherein a boom length is adjustable.

5. The pipe replacement system of claim **1**, further including a mechanism to select and fix an angle between the reaction plate and the boom.

6. The pipe replacement system of claim **1**, wherein the boom is removable from a second pulley located at the first end of the boom.

7. The pipe replacement system of claim **1**, further including a limiter to stop a pipe to be replaced from jamming the winch.

8. A method, comprising:

placing a boom into a pit diagonally from a winch corner to an exit corner;

running a cable from a winch, through a pipe to be replaced, to a bursting tool;

pulling the bursting tool through the pipe to be replaced while pulling a new pipe behind the bursting tool;

pulling the bursting tool around a pulley at a distal end of the boom, and into the pit, the pulley having a polymeric bursting tool guide surface; and

using a limiter to keep the pipe being replaced from pulling out of the ground and jamming the winch.

9. The method of claim **8**, further including removing the limiter as the bursting tool exits the ground, and pulling an amount of the new pipe into the pit.

* * * * *